APPLICATION FOR UNITED STATES LETTERS PATENT

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TITLE: METHOD AND MACHINE FOR PRODUCING A NONWOVEN FOR THE FILTER ROD PRODUCTION

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CROSS-REFERENCE TO RELATED APPLICATION

[0001] This application claims the priority of European Patent Application No. 03 018 113.5, filed on August 8, 2003, and European Patent Application No. 03 007 675.6, filed on April 3, 2003, the disclosures of which, together with the disclosure of each U.S. and foreign patent and patent application mentioned below are incorporated herein by reference.

BACKGROUND OF THE INVENTION

[0002] The invention relates to a method and a machine for producing a nonwoven for filter rod production in the tobacco industry.

[0003] A method for processing filter material and the corresponding filter material processing machinery used in the tobacco industry are known from British Patent Document GB 718 332, in which material snippets are produced with a tobacco cutter and are then fed to a continuous rod machine in a manner similar to that in cigarette machines. The snippets are impregnated with a chemical agent to prevent an undesirable taste and to prevent the snippets from falling out of the end pieces of the subsequently produced filters. The snippets are conveyed with a roller to the operating region of a spiked

feed roller and are then moved by the spiked feed roller to a conveying belt, so that the snippets can subsequently be fed to a second spiked roller. The snippets are knocked from the second spiked feed roller by a further spiked or beater roller and supplied to a format device where the continuous filter rod is formed by wrapping material around the fiber rod. The cuttings consist of materials such as paper, cellulose, textile, synthetic materials and the like and have a texture that is similar to cut tobacco.

[0004] The shape of the snippets makes it very difficult to produce filters with homogeneous characteristics. In addition, the options of adjusting the filter characteristics are very limited.

[0005] A method and a machine for producing a nonwoven for the manufacture of filter rods of the tobacco industry is known, for example, from German patent document DE 31 30 827 A1. As disclosed therein, a filler material for cigarette filters is produced by guiding a web or flow of continuous fibers of the filler material onto a spiked feed roller, which is driven with a speed that allows the spikes to tear the fibers into irregular length pieces. The pieces are discharged from the roller at a random orientation. The torn fibers are then poured onto a conveying belt and transferred to a continuous supporting

web, consisting of the same or different filter materials. The supporting web and the filler material are then formed into a continuous filter rod. In order to form the continuous filter rod, it is supplied to a continuous rod forming machine where the support webs are pushed together from the side to form a continuous rod. Thus, a continuous filter rod is produced during the longitudinal axial transport. Following the production of the continuous filter rod, the rod is then cut into individual filter-rod lengths.

BRIEF SUMMARY OF THE INVENTION

[0006] In contrast to the above-mentioned prior art, it is an object of the present invention to provide an improved method and a machine for producing a nonwoven for the production of filter rods and/or continuous filter rods.

[0007] This and other objects are solved according to the invention by the provision of a a method for producing a nonwoven for the production of filter rods in the tobacco industry, including separating fibers of at least one type of filter material in at least one separating device having at least one separating element rotating about a rotational axis. The separated fibers are

then fed to a conveyor moving in a conveying direction such that the separated fibers form the nonwoven.

[0008] The method according to the invention makes it possible to compile fibers uniformly on the conveyor, so that the quality of the nonwoven that is formed and/or compiled on the conveyor is increased and thus also the quality of the fiber rod formed with this nonwoven and the quality of the filter rods produced from this continuous fiber rod.

[0009] If the rotational axis is essentially oriented parallel to the conveying direction of the conveyor, the fibers can be poured on in a particularly uniform manner.

[0010] The effectiveness of the separation and thus the degree of separation can be increased if the fibers of at least two types of fiber materials are separated inside separate separating devices, with one type of fiber being separated in each separating device. The separated fibers are advantageously combined shortly before reaching the conveyor, such that it is not necessary to premix the fibers.

[0011] Thus the object of the invention is also solved with a method for producing a nonwoven for the filter-rod production in the tobacco industry in which

fibers of at least two types of filter materials are respectively separated in separate separating devices. The separated fibers are combined and fed to a conveyor moving in a conveying direction such that the separated fibers form the nonwoven.

[0012] In an exemplary embodiment, the separated fibers are combined directly in front of the conveyor.

[0013] With the methods according to the invention, the quality of the nonwoven that forms can be increased because the separation of the fibers into at least two types of fiber materials in separate devices leads to an increased degree of separation, and subsequently, to a more homogeneous fiber distribution of the compiled nonwoven. One type of filter material is respectively separated in each device. In the process, the quality of the nonwoven itself is increased, along with the quality of the continuous filter rod, and subsequently, the cut filter rod segments cut from it.

[0014] A more uniform distribution of the fibers on the conveyor can be achieved if the separating devices each comprise one separating element that rotates around a rotational axis that is essentially oriented parallel to the conveying direction of the conveyor. In

one exemplary embodiment of the method according to the present invention, the fibers and/or the fiber material is supplied from the top and compiled on the conveyor. As a result, a compact process guidance is possible.

[0015] Highly effective continuous filter rods and/or filter rod segments can be produced if the type of fiber is a multi-component fiber, in particular a bi-component fiber. With respect to these materials, reference is made to the European Patent Application No. 03 004 594.2 by the assignee of the present application, entitled "ZIGARETTENFILTER UND VERFAHREN ZUR HERSTRELLUNG DESSELBEN" ["Cigarette Filters and Method for Producing Same"]. The multi-component and/or bi-component fibers permit a bond between the fibers in the continuous filter rod and/or the filter rod section. For this, the multi-component fibers, particularly the bi-component fibers, have a core and an envelope of different types of materials, in which the filler material has a lower melting point than the core material. A very secure bonding of the fibers in the filter can thus be produced. The filter and/or the fiber mixture, which is available as filter material and/or from which the filter and/or filter rod is produced, can be heated to a temperature that is somewhat

above the melting point of the wrapping material. The filter components adhere to each other in this way.

[0016] With a respective bi-component fiber, the envelope can consist of polyethylene (PE) and the core, for example, of polyester and/or polyethylene terephthalate (PET). The melting point for the envelope in this example is about 127 °C and the core melting point is about 256 °C. A bi-component fiber with high dimensional stability is thus formed. One bi-component fiber that can be used may be obtained from the company Trevira. This bi-component material has the type designation 255, has a titer of 3.0 dtex, a cutting length of between 3 and 6 mm, a core made from PES (a synthetic fiber polyester fiber), and an envelope and/or cover made from co-polyethylene, in which the envelope and/or the cover is modified to increase the adhering ability. In an exemplary embodiment, the cover is provided with additives that result in a lower surface tension.

[0017] When energy is supplied to the filter material, the filter materials can adhere and/or stick at least at some contact points to the multi-component fibers and/or the bi-component fibers. Given a temperature above the envelope melting temperature, the envelope material is correspondingly softened and/or melted such that an

adhesive connection and/or a bond with other filter components can develop at the contact points. A filter with high dimensional stability is thus obtained after the respective filter components have cooled down.

[0018] A filter rod with improved filter quality can be produced if at least one type of granulate and/or powder is added just before feeding the material to the conveyor. Within the framework of this invention, the term granulate also covers the term extrudate. In one exemplary embodiment, the filter material and/or composite filter material consists of 80% to 95% by weight activated carbon granulate and 5% to 20% by weight of fibers, in particular bi-component fibers. It is also possible to produce filters made from diverse fibers, such as bi-component fibers, cellulose fibers and activated carbon fibers, in which the component and/or share of the bi-component fibers is between 5% and 20% by weight and the share of cellulose fibers is between 20% and 95%. The remaining material can comprise, for example, activated carbon fibers.

[0019] In the exemplary embodiment, transport air is used for transporting and/or separating the fibers. The low pressure in the conveyor region can subsequently be used to remove most of the transport air.

[0020] According to another aspect of the invention, there is provided an arrangement for producing a nonwoven for the manufacture of filter rods in the tobacco industry. The arrangement includes at least one separating device for separating fibers of at least one type of filter material. The at least one separating device includes a rotating separating element. The arrangement further includes a conveyor onto which the separated fibers are poured to form a nonwoven.

[0021] A high degree of fiber separation can be achieved with the rotating separating element to result in a uniform density of the produced nonwoven.

[0022] If the rotational axis of the separating element is oriented essentially parallel to the conveying direction of the conveyor, an even more uniform density of the nonwoven can be achieved. As a result of the special orientation of the separating drum, it is possible to supply individual fibers evenly to the conveyor. The quality of the nonwoven that is produced thus increases, and with it, the quality of the filter rods produced with this nonwoven.

[0023] The degree of fiber separation can be increased if at least two separate separating devices are provided. In an exemplary embodiment, the separating

devices are arranged side-by-side in conveying direction, not behind one another. The separating devices are designed such that respectively one type of fiber is separated. For this, the separating drums in the separating devices are provided with differently designed screens, for example, screens that can be adapted to the respective fiber diameter and/or length. If a separate conveying chute is provided downstream of each separating device, then the individual fibers can be supplied securely to the conveyor.

[0024] An effective mixing of the fibers and/or additional filter material components occurs if the conveying chutes converge directly in front of the conveyor to form a chamber. Additional filter components such as granulates, powders and/or extrudates, can also be supplied to a conveying chute and/or to conveying chutes that converge together with the other conveying chutes to form the chamber.

[0025] The object is furthermore solved with a machine for producing a nonwoven for the production of filter rods in the tobacco industry. The machine includes at least two separating devices for respectively separating the fibers of one type of filter material. A conveying

chute is provided for each separating device, and the separating devices are separated from each other.

[0026] The degree of fiber separation is thus increased such that the quality of the fiber nonwoven and the subsequently produced filter rods are increased. In an exemplary embodiment, the separating elements are separating drums, particularly drums having differently designed screens.

[0027] In an exemplary embodiment, the separation devices are arranged side-by-side in the conveying direction, not one behind another. The fibers from one side are fed exclusively to one of the separation devices, and not to the other one.

[0028] The fibers used to form a nonwoven can be poured onto the conveyor in an extremely uniform manner if the conveyor is arranged downstream of the separating devices and is designed for receiving the separated fibers to form the nonwoven. For this, the separation devices comprise respectively one separation element with a rotational axis that is essentially oriented parallel to the conveying direction of the conveyor.

[0029] An effective mixing of the fibers is possible if the conveying chutes converge in the downstream direction to form a chamber at the end. An exemplary

embodiment according to the invention also provides for conveying chutes for supplying granulates, powders, extrudates or other filter materials to the chamber.

[0030] A very efficient and space-saving arrangement can be realized if the at least one separation device is arranged above the conveyor and the filter material is supplied directly from the top and compiled on the conveyor.

[0031] One exemplary method for producing a filter rod comprises the following steps: transporting finite, essentially completely separated fibers of at least one type with the aid of transport air and in the conveying direction of a conveyor; forming a fiber nonwoven on one surface of a conveyor from fibers that at least partially contact each other; depositing the fiber nonwoven on a wrapping web; and wrapping the fiber nonwoven with the wrapping web.

[0032] A continuous filter rod with very homogeneous filter characteristics is obtained when essentially completely separated fibers are transported, in particular with transport air, in the direction of a conveyor, such that a fiber nonwoven forms on a conveyor surface. In the exemplary embodiment, the conveyor is a belt conveyor, and can be provided with a suction belt.

[0033] A uniform shape of the continuous filter rod can be achieved if the fiber nonwoven is compacted while being wrapped with the wrapping material web. Supplying energy to the fiber nonwoven during wrapping generates a solid bond at the fiber contacting points to result in a relatively elastic filter and ensures that no fiber material is lost at the cutting edges of the filter and/or the filter element.

[0034] Particularly homogeneous filter characteristics can be obtained by using fibers having a fiber length that is shorter than the length of the filter and/or filter element cut from the produced continuous filter rod. In an exemplary embodiment, the fibers utilized have an average fiber diameter in the range of 10 to 40μm, and can be in the range of 20 to 38μm. Thus, in an exemplary embodiment, the fibers are elongated and relatively thin. The filter characteristics can be adjusted if additives such as activated carbon granulate, triacetin or latex are added to the fibers. Activated carbon granulate is added, for example, to the fibers before they are completely separated or is added to the fibers being transported to the conveyor. Triacetin and/or latex as bonding agents are added, for example, to the compiled fiber nonwoven in the conveyor region.

[0035] A particularly uniform compaction is ensured if the fiber nonwoven is compacted prior to the step of depositing on the wrapping material web. For this, the material is compacted vertically as well as horizontally, i.e., from the top and from the bottom as well as from the sides of the fiber nonwoven.

[0036] A particularly simple process sequence is ensured if the fiber nonwoven is removed from the conveyor with mechanical force, in particular with compressed air, to deposit the fiber nonwoven on the wrapping material web.

[0037] In a further exemplary embodiment, the fiber nonwoven is formed prior to being deposited on the wrapping material web. This forming step, for example, can include at least the forming of a semicircle crosswise to the conveying direction of the nonwoven, or a full circle or oval can be formed.

[0038] A filter or a filter element is produced according to the invention by subsequently cutting the continuous filter rod into sections of a specific length.

[0039] The present invention also includes a machine for producing a continuous filter rod. The machine includes a fiber compiling device that transports separated

fiber materials with transport air to a conveyor to form a fiber nonwoven; a format device that wraps a material web around the fiber nonwoven; and a transferring device that subsequently transfers the fiber nonwoven from the conveyor to the format device.

[0040] A particularly homogeneous fiber nonwoven can be produced by transporting the separated filter materials with transport air, such that an especially homogeneous continuous filter rod can be produced, to result in particularly homogeneous filter and/or filter elements.

[0041] The filter characteristics can be positively influenced if at least one compacting device is provided in the area of the conveyor. In an exemplary embodiment, the conveyor or a section of the conveyor can form a component of the compacting device. The conveyor can be at least one suction belt. If the processed fibers are small enough so that the openings of the suction belt are quickly clogged, it is advantageous if two additional suction belts are used for the operation, which are respectively arranged at approximately a right angle on both sides of the first suction belt. The fiber nonwoven can be transferred with particular efficiency if compressed air is used to remove the nonwoven from the conveyor.

[0042] If the device for transferring the fiber nonwoven comprises a transport belt, then the fiber nonwoven can be shaped to meet the characteristics and/or the form of the filter to be produced. In an exemplary embodiment, the transport belt is a suction belt, and the transport belt can be bent crosswise to the transporting direction, thus making it easy to produce, for example, a continuous filter rod with circular and/or oval cross section. Two transport belts can be provided to hold and transport the fiber nonwoven in between to form the circular and/or oval cross section. The transport belts can be designed such that the fiber nonwoven is formed into an oval shape, a circular shape, a semi-circular shape, or a half-oval shape.

[0043] An alternative transfer device for transferring the fiber nonwoven includes a nozzle through which the fiber nonwoven can be transported. In an exemplary embodiment, the nozzle is designed such that the fiber nonwoven can assume a round or oval shape.

BRIEF DESCRIPTION OF THE DRAWINGS

[0044] The invention is described in the following with the aid of exemplary embodiments and without restricting the general inventive idea by referring to the

drawings, to which reference is made for all details of the invention not explicitly explained in the text.

[0045] Figure 1 shows a three-dimensional schematic representation of a separating device and a section of a compiling device in accordance with the present invention.

[0046] Figure 2 shows a schematic view of a first exemplary embodiment of a continuous filter rod machine in accordance with the present invention.

[0047] Figure 3 shows a plan view of a section of the continuous filter rod machine of Fig. 2, as viewed in the direction of arrow A.

[0048] Figure 4 shows a side view of a section of the continuous filter rod machine of Fig. 2, as viewed in the direction of arrow B.

[0049] Figure 5 shows a schematic view of a second exemplary embodiment of a continuous filter rod machine in accordance with the present invention.

[0050] Figure 6 shows a plan view of a section of the continuous filter rod machine of Fig. 5, as viewed in the direction of arrow A.

[0051] Figure 7 shows a side view of a section of the continuous filter rod machine of Fig. 5, as viewed in the direction of arrow B.

[0052] Figure 8 shows a side schematic view of a section of the continuous filter rod machine of Fig. 2, with portions the machine omitted for reasons of clarity.

[0053] Figure 9 shows a top schematic view of the section of the continuous filter rod machine shown in Fig. 8.

[0054] Figure 10 shows a schematic three-dimensional section of the continuous filter rod machine shown in Fig. 2.

[0055] Figure 11 shows a schematic view of a section of a continuous filter rod machine shown in Fig. 8.

[0056] Figure 12 shows a schematic view of a section of a continuous filter rod machine shown in Fig. 2.

[0057] Figure 13 shows a schematic three-dimensional representation of an alternate embodiment of a machine according to the invention for producing a nonwoven.

[0058] Figure 14 shows a schematic sectional side view of a variant of the machine shown Fig. 13.

DETAILED DESCRIPTION OF THE INVENTION

[0059] In the Figures described herein, the same reference numbers are used for identical or similar

elements and/or parts, so that these do not need to be introduced again.

[0060] Referring to Fig. 1, there is shown a three-dimensional representation of a separating device 10 which is a variant of a separating device disclosed in European Patent Application No. 03007672.3 by the assignee of the present application and entitled "VERFAHREN ZUR AUFBEREITUNG ENDLICHER FASERN UND AUFBEREITUNGSEINRIGHTUNG FUER ENDLICHE FASERN ZUR VERWENDUNG BEI DER HERSTELLUNG VON FILTERN" ["Method for Processing Finite Fibers and Processing Device for Finite Fibers Used for the Production of Filters,"], filed on August 8, 2003 in the European Patent Office. The above-mentioned European Patent Application is directed to the respective processing of fiber material used for the production of filters to obtain essentially completely separated fibers for producing a homogeneous continuous filter rod. The separating device 10, among others, can be used for this purpose. If necessary, the filter material and/or the fiber material is separated and portioned out ahead of time.

[0061] The mostly non-separated fiber material and/or fiber/fiber group mixture 49, as shown in the schematic representation of Fig. 4, is moved via an accumulation chute 44 and feed rollers 46 to the operating

range of a spiked feed roller 76, which knocks out and pre-separates the fiber/fiber group mixture 49. This fiber/fiber group mixture 49 is then transported with air flow 19 to a screening drum 21, as shown in Fig. 1, via openings 20 on the side of a housing 22. In Fig. 1, two screening drums 21 are shown. The fiber material is blown into the housing 22 in the direction of the longitudinal axes of the screening drums 21. A circular flow 23 is generated when the fiber material is blown in from both sides of the screening drums 21 in counter-clockwise direction in this exemplary embodiment. Below the screening drums is a fluidized bed region 11. (See Fig. 1) The circular flow 23 through the screening drums 21 is superimposed by a normal flow and/or a flow that is essentially perpendicular to the circular flow 23 and is generated by a low pressure at an end 14 of the fluidized bed 11 that results in air flow 13. The air flow 13 represents one option for larger, heavier fibers, which is not always required. The low pressure existing at the end 14 of the fluidized bed region 11 is generated by the low pressure of a suction-belt conveyor (not shown in Fig. 1), as well as by an air flow 17 through an exhaust pipe 16. (See Fig. 1) The normal flow 13 starts above the screening drums 21 and passes or flows through the sleeve openings of

the screening drums 21, and then reaches and passes through fluidized bed region 11 until it reaches the end 14.

[0062] In the screening drums 21, the fiber material that is not or for the most part not separated reaches the inside surfaces of the sleeves for screening drums 21. The screening drums 21 rotate in a clockwise rotational direction 24. The mostly non-separated fiber material that is deposited on the inner sleeve surfaces of the rotating screening drums 21 is supplied to the separating drums 26. The separating drums 26 rotate counter-clockwise in the direction 25 and are located offset with respect to the center-axis of the screening drums 21. However, they can also alternatively rotate in a clockwise direction, as well as in any other conceivable variations of the rotational direction. The separating drums 26, which are needle rollers in the exemplary embodiment, pick up the non-separated fibers, tear them apart, and accelerate them. The fibers are tossed against the inner sleeve surface of the screening drums 21 until they have separated into individual fibers and have passed through and/or can pass through the sleeve openings of the screening drum 21. In an alternate embodiment, a drum with perforated sheets or a rod-type grids can replace the screening drum 21.

[0063] The separated fibers are picked up by an air flow and are guided and/or pulled through the sleeve openings in the screening drum 21. The air flow moves the fibers downward toward the fluidized bed 11 and along the fiber flow 18. As soon as the fiber flow 18 arrives at the fluidized bed 11, the flow 18 is deflected and guided along the curved fluidized bed 11. As a result of the centrifugal forces acting upon the fibers, the fibers move toward the curved guide wall and flow to the suction belt conveyor (not shown in Fig. 1). The air flowing along above the fibers is removed at a wedge and/or separator 15 and is released through exhaust pipe 16.

[0064] Optionally, individual fibers are picked up by an air flow 13 coming from a nozzle lip 12 and are also supplied to the fluidized bed end 14, wherein several nozzle lips can also be provided.

[0065] Fiber groups that are not or not completely separated following a single passage through one of the screening drums 21 reach the respectively parallel, second screening drum 21 via the circular flow 23. The separating device shown in Fig. 1 at least in part corresponds to the device disclosed in International Patent Publication No. WO 01/54873 A1 and/or U.S. Patent No. 4,640,810 A, which are assigned to Scanweb of Denmark and

the United States and can be utilized in the present invention.

[0066] The fibers are essentially separated in a joint operation between the screening drums 21, the separating drums 26, and the air flow 19, 23 through the screening drums 21. In particular, essentially completely separated fibers are ensured by providing that only separated fibers are able to pass through the openings in the screening drums 21.

[0067] The fiber flows 18, generated by the transport air, move the separated fibers in the direction of the fluidized bed end 14. The thickness of the fiber flow 18 through the fluidized bed 11 is continuously reduced as a result of the centrifugal force. The flow divider 15 is provided for separating the air from the fibers.

[0068] Turning to Figs. 2-4, the non-separated fiber material 49 travels via the accumulation chute 44 to the metering device formed by the two feed rollers 46, a metering channel arranged between the feed rollers 46, and the spiked roller 76. The schematic representation in Fig. 3 shows that the direction of the material feed-in 47 is downward and into in the drawing plane. The non-separated fiber material 49 is separated inside the separating device

10 (see Fig. 4). The separation of the fibers occurs through a joint operation of the separation rollers 26, an air flow 50, and openings in a grid or screen 77, which divides the separating chamber 45 from the space that is assigned to the fluidized bed 11. The air flow at the fluidized bed 11, generated by the air flow in the exhaust pipe 16, transports the separated fibers 27. As shown in Fig. 3, the direction of the air flow 17 in the exhaust pipe 16 is upward and out of the drawing plane, wherein the air flow 17 also removes excess fibers.

[0069] The separated fibers 27 move along the fluidized bed 11 in the direction toward the fluidized bed end 14 where a conveyor 32, particularly a suction belt 43, is arranged. A low pressure exists at the conveyor 32 as a result of the air continuously being suctioned out, which is shown schematically by air flow 28. The low air flow 28 holds in place the separated fibers 27 against the air-permeable suction belt 43.

[0070] The suction belt conveyor 43 moves in the direction of the continuous rod machine 9, which is to the left in Fig. 2. A fiber cake and/or fiber flow 29 is compiled on the suction belt and increases nearly linearly in size in the direction toward the continuous rod machine 9. The compiled fiber flow 29, which varies in thickness,

is trimmed with a trimming device 31 to reach a uniform size at the end of a compiling zone on the suction belt conveyor. The trimming device 31 can be a mechanical device, for example, trimming disks or plates, or a pneumatic trimming device such as air nozzles. In a pneumatic trimming device, a nozzle that discharges the air flow is arranged horizontally at the end of the fiber flow 29 and removes out a portion of the fiber flow 29, so that excess fibers 30 are removed. A circular or a flat nozzle can be used.

[0071] After the trimming operation, the fiber flow 29 is divided into a trimmed fiber rod 33 and an excess fiber rod 30. A nozzle can also be used to pick up and remove off all fibers below a trimming dimension. The excess fibers 30 are returned to the fiber preparation process and can later be used to form another fiber rod.

[0072] The trimmed fiber rod 33 is held against the suction belt 43 and is moved in the direction of the continuous rod machine 9. At this point, the trimmed fiber rod 33 is a loose fiber nonwoven which is compacted with the aid of a compacting belt 35. However, it is also possible to use a roller, for example, a press roll 55 as shown in Fig. 5, in place of the compacting belt 35 or to use several belts, rollers, and/or pulleys. As shown in

Fig. 3, the fiber cake is furthermore also compacted on the sides by compacting belts 48 which are angled towards one another in the movement direction. The compacting belts 48 are operated in an exemplary embodiment at the speed of the suction belt 43. The serrated or toothed shape of the compacting belts 48 creates zones of varying density in the compacted fiber cake. The filter rod is later on cut in the zones with the higher density or compaction. The higher fiber density in the filter end region ensures a more compact consistency of the fibers in this sensitive zone and, additionally, makes it easier to process the filter rods.

[0073] The trimmed and compacted fiber rod 34 is transferred to the continuous rod machine 9. For transfer to the continuous rod machine 9, the compacted fiber rod 34 is lifted off the suction belt 43 and the fiber rod 34 is then deposited on a format belt 58 and/or on a wrapping material web 42 on the format belt 58 of the continuous rod machine 9. (See Fig. 8) The format belt, which is not shown in the Figs. 1-4, can be a standard format belt. The transfer is aided by a nozzle 36, which directs an air flow 37 from the top onto the compacted fiber rod 34. A fiber filter rod 38 is formed in the continuous rod machine 9 by pulling a wrapping material web

42 from a bobbin 41 and wrapping the wrapping material web 42 around the fiber material 38. A certain internal pressure builds up in the fiber filter rod 38 as a result of volume reduction and the shaping of the compacted fiber rod 34 into a circular and/or oval form during the wrapping with the wrapping material web 42 or, as shown in the following embodiments, before the wrapping with the wrapping material web 42.

[0074] Bonding components that are contained in the fiber mixture are surface heated and slightly melted in a curing device 39. For example, bi-component fibers can be used, the outer layers of which can be melted so that a bond is created between the fibers. For this, reference is made to German Patent Document DE 102 17 410.5 owned by the assignee of the present invention. A plurality of fibers suitable for providing the desired filter characteristics can be used for the fiber materials, particularly cellulose acetate, cellulose, carbon fibers and multi-component fibers, particularly bi-component fibers.

[0075] In another exemplary embodiment, different fiber types are mixed prior to the formation of the rod. It is furthermore possible to add at least one additive, for example a bonding agent such as latex or triacetin or a granulate material, such as activated carbon

granulate, which is particularly effective for bonding components of cigarettes.

[0076] In yet another exemplary embodiment, the length of the fibers is shorter than the length of the filter and/or the filter element to be produced. Consequentially, the fiber length in the exemplary embodiment should be between 0.1mm and 30mm and, in particular, between 0.2mm and 10mm. With respect to the length, the filter to be produced can be a standard cigarette filter and/or a filter segment for multi-segment filters used for cigarettes. If the average fiber diameter additionally is in the range of 10 to 40μm, in particular 20 to 38μm, more particularly between 30 and 35μm, a very homogeneous filter can be produced.

[0077] The curing device 39 can include one or more of the following: a microwave heater, a laser heater, heating plates and sliding contacts. By heating the bonding components, for example in the outer layer of the bi-component fibers or latex material, the individual fibers in the continuous fiber rod will bond and melt together on the surface. The curing device 39 can also be used to dry bonding components which are added in liquid form. During the cooling down of the continuous fiber rod, the slightly melted regions of the heated bonding

components will harden again. The resulting grid imparts stability and hardness to the continuous fiber rod.

[0078] The cured fiber filter rod 38 is subsequently cut into individual filter rod elements 40. However, the filter rod can also be cured following the cutting into individual filter elements 40.

[0079] Referring to the embodiment of Figs. 5-8 and in contrast to the continuous-rope machine 9 shown in Figs. 2-4, the separated fiber material 27 is compiled from above onto the suction belt 43 in transport direction 74. The separating device 10 of Figs. 5-7 represents a modified embodiment of the separating device 10 in Fig. 1. The separating chamber 45 contains screening drums 21 that rotate in the direction of the arrow 24. In a modified machine as compared to Fig. 1, however, the separating rollers 26, for example spiked feed rollers, are arranged in the center of the screening drums 21. As in the previous embodiment, the spiked feed rollers 26 function to tear apart and separate the fiber material that has not yet been separated and/or the cohesive fiber groups into individual fibers, so that the separated fibers can pass through the discharge openings in the screening drum 21 and into the funnel 53. Owing to the respective air flows and the force of gravity, the separated fibers 27 then reach

the suction belt conveyor 43, which in this embodiment has suction belt side walls 57 (Fig. 7) .

[0080] The fibers 27 are compiled in a homogeneous manner, in particular because the screening roller 21 encircles a separating roller 26 such that the longitudinal axes of the screening roller and the separating roller, in particular the rotational axis 91 of the separating roller 26, are oriented parallel and/or essentially parallel to the conveying direction 92 of the suction belt conveyor 43. Due to the special orientation of the screening drum 21 and the separating drum 26, the fiber flow 29' is deposited uniformly on the conveyor 43.

[0081] A corresponding fiber nonwoven 29 is compiled on the suction belt 43. Excess fiber material 30 is removed from above with the aid of a trimmer 31 from the remaining fiber rod 33. The trimmed continuous fiber rod 33 is compressed with a press roll 55, which simultaneously functions in the rod conveying direction as the rear reversing mechanism of the suction belt 43'. Shortly after the press roll 55, the compacted continuous fiber rod 34 is held from above by a suction belt 43'. For this, a low pressure field 54 is generated with an air flow 28. An air flow 37 then flows through the nozzle 36 onto the suction belt for removing the rod from the suction belt 43'. The

compacted continuous fiber rod 34 is removed from the suction belt 43' with the air flow 37 from nozzle 36 and is transferred to a format device 56. In the process, the compacted fiber rod 34 is deposited onto a wrapping material web 42, which is conveyed on a format belt. The remaining process steps correspond to those shown in Figs. 2 to 4.

[0082] Referring to Fig. 8, which schematically shows a section of a machine in accordance with the present invention, the suction belt 43 is reversed around rollers 59. The gradually built-up fiber nonwoven 29 becomes the trimmed continuous fiber rod 33 following the trimming operation. The trimming device is not shown in Fig. 8. In the compiling region for fiber nonwoven 29 shown in Fig. 8, individual fibers 27 reach the continuous fiber rod from below.

[0083] The continuous fiber rod 33 is subsequently deposited on a wrapping material web 42 that is positioned on a format belt 58. The format belt 58 and the wrapping material web 42 are deflected with corresponding rollers 59, 59', respectively. In the region of a roller 61, the fiber rod 33 is deposited onto the wrapping material web 42, which represents the start of the

format device 56 at which the wrapping material web 42 is wrapped around the continuous fiber rod 33.

[0084] Fig. 9 shows a view from above of the device shown in Fig. 8, and shows in particular side walls 57. The separating device is not shown in Fig. 9 for clarity. The side walls 57, which also adjoin the continuous fiber rod 29 and/or 33, are formed by suction belts 43' which, in turn, are reversed by reversing rollers 59''. In the illustrated embodiment, three suction belts are shown, which is useful if the fibers are especially short and thin, so that the fiber material is correspondingly held against the suction belt and/or the suction belts.

[0085] Fig. 10 illustrates a device for transferring the fiber rod from the suction belt 43 to the format device 56 and, in particular, to the wrapping material web 42. The continuous fiber rod (not shown in Fig. 10) is transported from the lower region of the suction belt 43, which is reversed with the reversing roller 59, to a clearance space between the oppositely arranged belts 62 in direction 75.

[0086] The curved belts 62, which can be steel belts in an exemplary embodiment, are reversed with the aid of curved rollers 63. A circular hollow space is thus

created between two oppositely arranged belts 62. The continuous fiber rod passes through this hollow space with circular cross section and is deposited on the wrapping material web 42. The fiber rod 34 (see Figures 2 and 5) can be pre-formed and, if necessary, additionally compacted with the transfer device. The suction belt side walls 57' for this embodiment are designed as solid side walls.

[0087] Fig. 11 shows a section of a continuous rod machine 9 in accordance with the invention, wherein fiber flow 29, consisting of fibers 27, which is supplied from above through a funnel 53 and compiled on the suction belt 43 is conveyed to the operating range of a hugger belt 64, which is reversed around rollers 65. The respectively compacted fiber rod enters a nozzle 66 and is conveyed further with an air flow 67 to the wrapping material web 42 which rests on the format belt 58. The fiber rod 38 is subsequently wrapped with the wrapping material web 42 to form the continuous fiber filter rod 38.

[0088] An alternate embodiment for transporting the fiber rod 33 to the format belt 58 is shown in Fig. 12. The fiber rod 33 is conveyed by the suction belt 43 to the operating range of a nozzle 68, which blows compressed air 69 onto the fiber rod 33 in the region of the reversing roller 65, thus separating the continuous fiber rod 33 from

the suction belt 43. The angle for the nozzle 68 and/or the compressed air 69 blown onto the fiber rod 33 can be adjusted. After the fiber rod 33 is separated from the suction belt 43, the fiber rod 33 travels to the ring nozzle 70. The air 67 flowing through the nozzle slit 71 can perform various functions, depending on the nozzle design. However, the function in the exemplary embodiment involves separating the fiber rod 33 from the suction belt 43, which runs around the reversing roller 65 and can also be designed as press roll 55, with the aid of the low pressure existing in the nozzle feed channel of nozzle 70. In addition, the compressed air 67 blown against the fiber rod at specific angles can convey the fiber rod to a first format-forming hollow cone 72. According to a modification, the compressed air 67 can dissolve the rod into individual fibers and/or fiber groups and thus convey the individual fibers and/or fiber groups into the first format-forming hollow cone 72, and subsequently into a second format-forming hollow cone 73. The format belt 58 with the wrapping material web 42 positioned thereon passes underneath the second format-forming hollow cone 73. The second hollow cone 73 has a smaller taper than the first hollow cone 72. The first format-forming hollow cone 72

contains venting bores which ensure the discharge of the nozzle air 69 and 67.

[0089] In another exemplary embodiment in which the fiber rod 33 is transferred as continuous fiber rod, the fiber rod is shaped from the top by the format-forming hollow cones 72 and 73 and from the bottom with the format belt 58 that passes through the format device. The complete transfer of the fiber rope 33 to the format belt and/or the wrapping material web 42 occurs below the hollow cone 73. In the second variant in which individual fibers and fiber groups are pressed into the format-forming hollow cone with the aid of nozzle air 69, a backup of the individual fibers and fiber groups occurs because of the taper in the hollow cone, so that a new fiber rod forms. This rod is formed completely in the second hollow cone 73 and is transferred at the end of the second hollow cone 73 to the format belt and/or the wrapping material web 42. The wrapping material web 42 is then wrapped around the rod to form the continuous fiber filter rod 38.

[0090] In contrast to cigarette rod production, the difficulty with the continuous filter rod production, as in the present invention, is that filter materials having fine fibers with or without additives such as activated carbon granulate or powder must be formed into

homogeneous filter rods. The various elements and/or devices must accordingly be configured so that the materials used are transported, held or processed in an optimum manner.

[0091] The fiber materials can be cellulose fibers, fibers of a thermoplastic strength, flax fibers, hemp fibers, linseed fibers, sheep's wool fibers, cotton fibers or multi-component fibers, in particular bi-component fibers having a length that is shorter than that of the filter to be produced and a thickness, for example, in the range of 25 to 30µm. For example, cellulose fibers of the type "stora fluff EF untreated" by the company Stora Enso Pulp AB can be used, which have an average cross section of 30µm and a length of between 0.4 and 7.2mm. For the synthetic fibers such as the bi-component fiber, it is possible to use fibers with a length of 6mm of the type Trevira 255 3.0 dtex HM by the company Trevira GmbH. These fibers have a diameter of 25µm. Cellulose acetate fibers, polypropylene fibers, polyethylene fibers and polyethylene terephthalat fibers can also be used for the synthetic fibers. Materials that influence the taste and/or smoke can also be used as additives, such as activated carbon granulate or flavoring agents, as well as bonding agents that make the fibers stick together.

[0092] Fig. 13 shows an alternate separating arrangement of the invention for producing a nonwoven for the production of filter rods in the tobacco industry. Five separating devices 80 are illustrated in Fig. 13, which are equipped with separating drums 81, for example in the form of screening drums, as described above in further detail. Separating rollers 26 can be arranged inside the separating drums 81, only one of which is shown in Fig. 13. Separating rollers 26 are also shown in particular in Figs. 1, 5 and 7. The separating drum 81 can be designed to rotate around a rotational axis 91 and/or fixed. If the separating drum 81 is fixed, a longitudinal axis is provided which coincides with the rotational axis 91 shown in Fig. 13. It is also possible to arrange a separating roller inside the separating drum 81, which rotates around a rotational axis 91 and/or a rotational axis that is parallel displaced to the rotational axis 91. The separating drums 81 and/or the screening drums are designed to effectively separate fibers of one type. For this, the width and length of the screens of the screening drum can be adjusted to the length and diameter of the fibers to be separated.

[0093] Conveying chutes 82 are arranged downstream of the separating devices 80 and feed the

separated fiber material to a joining element 83 provided with a chamber 87 in the lower region, into which the conveying chutes 82 empty. A suction belt conveyor 84 is arranged following the chamber 87 and/or in the lower region of the joining element 83.

[0094] The filter materials are mixed inside the chamber 87. The materials are conveyed primarily with transport air but also with the aid of gravitation, such that a thorough mixing is achieved as a result of turbulence in the transport air in the chamber 87. Downstream of the transfer region 85, granulates can be added to the mixed and separated fibers via an additional chute (not shown herein) that empties into the chamber 87, if necessary, and are then transferred to the operating range of the suction belt 86 of the suction belt conveyor 84 on which the fiber nonwoven is poured.

[0095] The mixing chamber 87 region in Fig. 13 is shown with further details in Fig. 14. In contrast to the machine shown in Fig. 13, the conveying chutes 82 initially run parallel in the upper region. Fibers 90 and granulates 89 are provided in this embodiment. Particularly, in the embodiment shown in Fig. 14, three different fiber types 90 and two different granulate types 89 are supplied to the chamber 87 and are subsequently

poured onto the conveyor belt 86 to form a fiber nonwoven 88. The conveying air is suctioned off below the suction belt 86 by the low pressure existing at that location.

[0096] In the embodiment of Fig. 14, the suction belt 86 moves in conveying direction 92 such that the thickness of the poured-on fiber nonwoven increases in conveying direction.

[0097] Once the nonwoven 88 is provided to the conveyor, the fiber nonwoven is fed to a continuous rod-forming device, as described in the above embodiments. The nonwoven can also be heated to melt the outer surface of the bi-component materials used as components of the filter material and/or the nonwoven, such that a solid and air-permeable bond develops after the curing of said components. In an exemplary embodiment, only one type of fiber is supplied to each separating device 80. The fibers are also portioned out while being supplied to the device 80.

[0098] The invention has been described in detail with respect to exemplary embodiments, and it will now be apparent from the foregoing to those skilled in the art, that changes and modifications may be made without departing from the invention, therefore, as defined in the appended claims, is intended to cover all such changes and

modifications that will fall within the true spirit of the invention.